GIS Advances and Transportation Planning

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NDSU UPPER GREAT PLAINS TRANSPORTATION INSTITUTE

Contents

- Evolution of transportation modeling enabled by advances in GIS
- Focus: freight modeling
- North Dakota statewide models
- Inland waterway models for USACE
- Future work and directions
  - Rail transportation

Evolution of Modeling

- Antecedents
  - Spatial modeling
    - Transportation and land use
    - Travel demand modeling
  - Operations research (non-spatial)
  - Infrastructure planning (non-spatial)
- Ad hoc/piecemeal approaches
- Aggregate geographic zones
- Ad hoc → integrated
- Aggregate → detail

Scope of ND Statewide Model

- Origins/destinations
  - 1,945 townships: crop production
  - 770 spacing units: oil production
  - ≈ 435 grain elevators
  - Oil transload facilities
  - Sugar beet piling stations and plants
- ≈ 90,000 road miles
- 4429 bridges
- 8,473 rail/highway crossings: 5,551 public

Objectives/Outcomes

- Forecast vehicle (truck) traffic on individual road segments
- Use traffic (truck) forecasts to estimate highway reconstruction and rehabilitation needs
- Requirements
  - Very specific (disaggregate) model
  - Fine-level land use model
    - 3,000+ origins/destinations

Modeling Steps

- Economic activity forecasts
- Trip generation (productions and attractions)
  - Quantity (e.g., tons, bushels, gallons)
  - Truckloads (by type of truck)
- Routing/network assignment
- Segment trips: truck ADT
- Investment needs models

ND Model Architecture

- Citilabs Cube
  - Voyager: routing, gravity model, assignment
  - Analyst: initial predictions → adjusted predictions → revisit initial assumptions
  - Cargo: truck traffic not specifically modeled
    - Based on Economic Census/County Business Patterns
- Network
  - ND GIS hub
  - HERE data from Citilabs (TIGER Files)

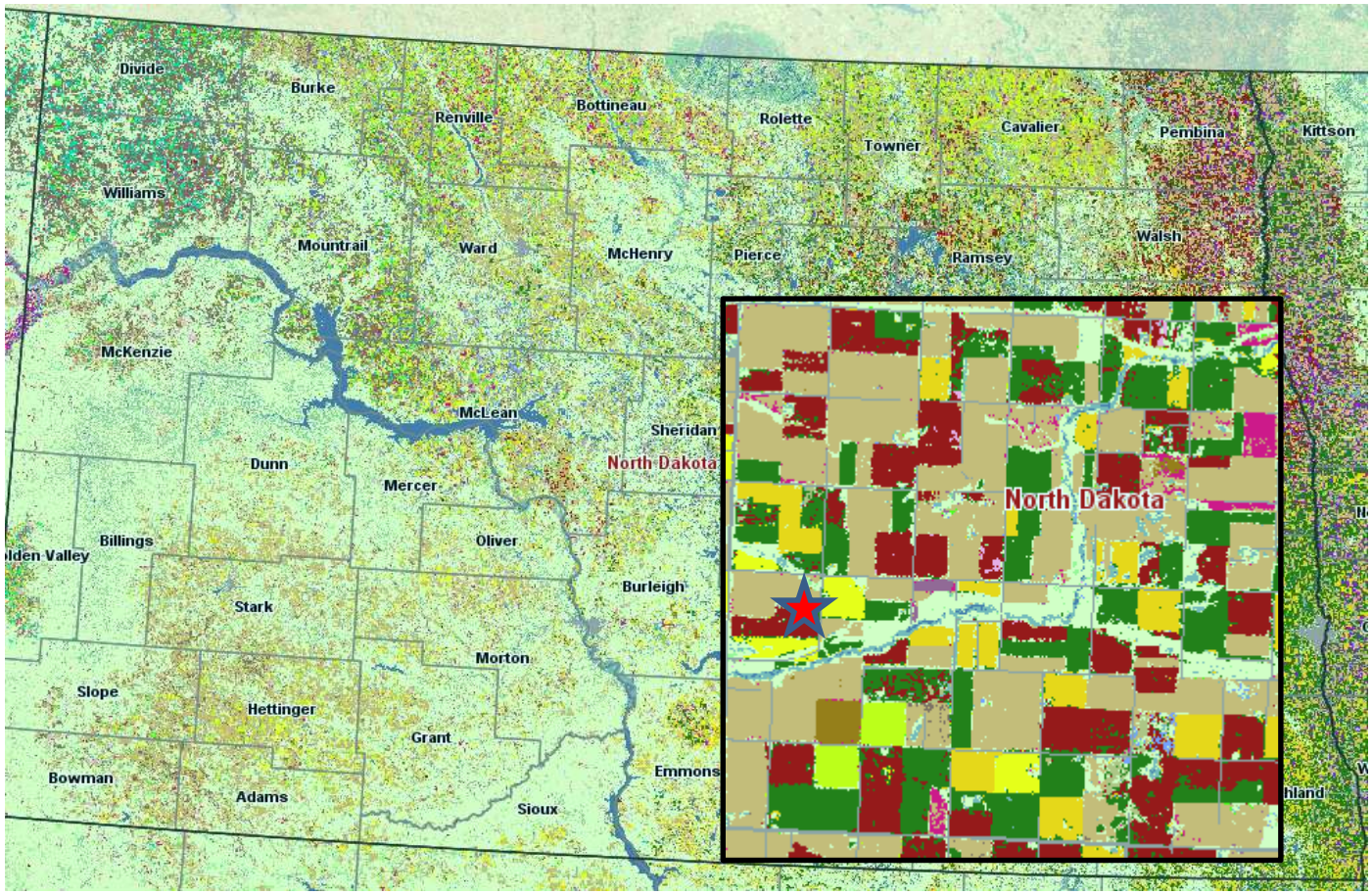
Network Enhancement

- Embed/connect bridges (NBI)
  - Apply bridge restrictions in routing
  - Weight limits/obsolete structures
  - Enhanced detour distance
- Embed/connect rail-highway grade crossings
  - Highway and rail network
  - Model train and truck traffic at same crossing
  - Truck traffic forecast at specific crossings

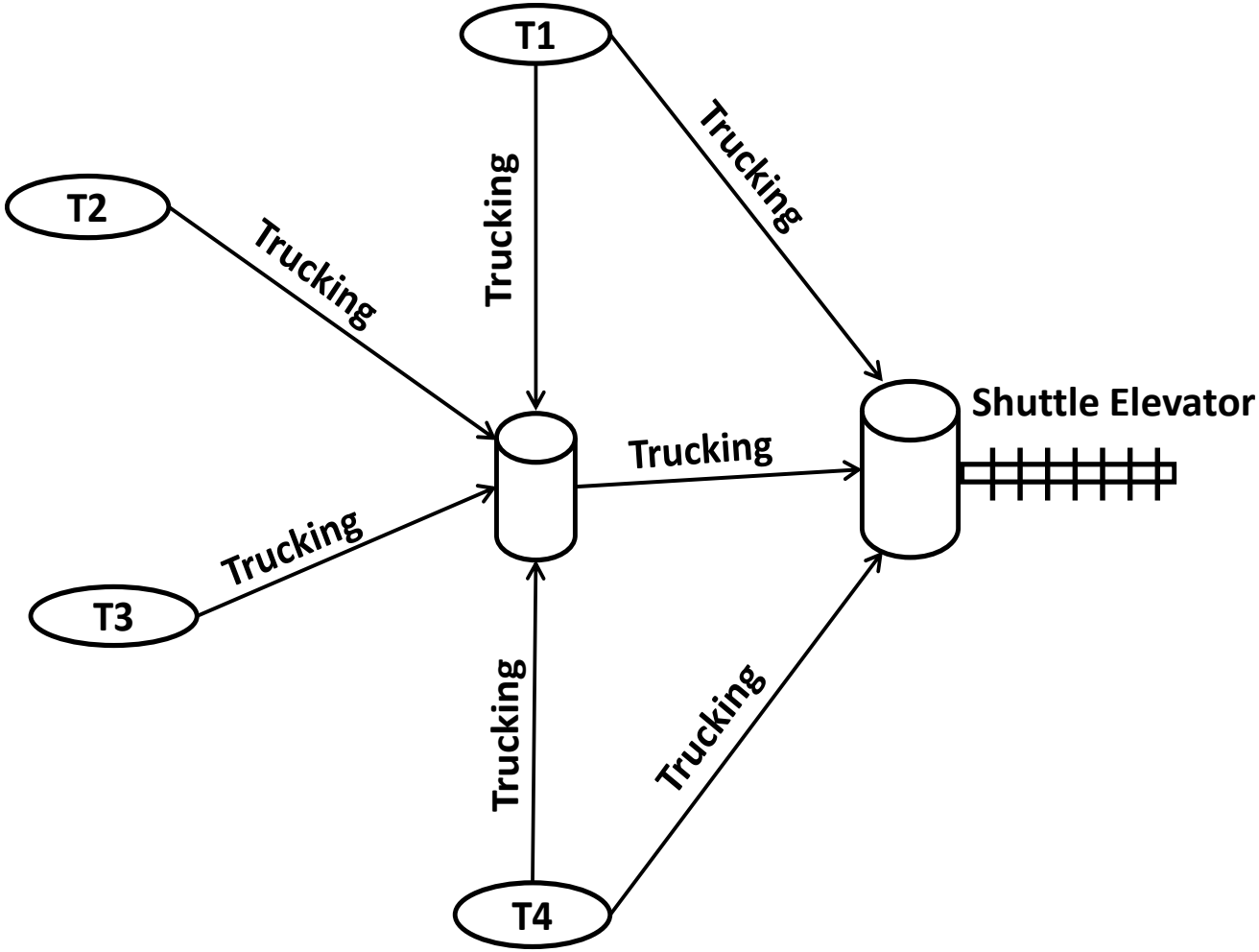
Agricultural Land Use Model

- Crop production data from NASS
- Convert crop satellite image to polygons
- Calculate area within crop polygon
- Calculate land areas of county and subdivisions
- Estimation production in polygon: area x yield
- Use reported county production to adjust initial estimates

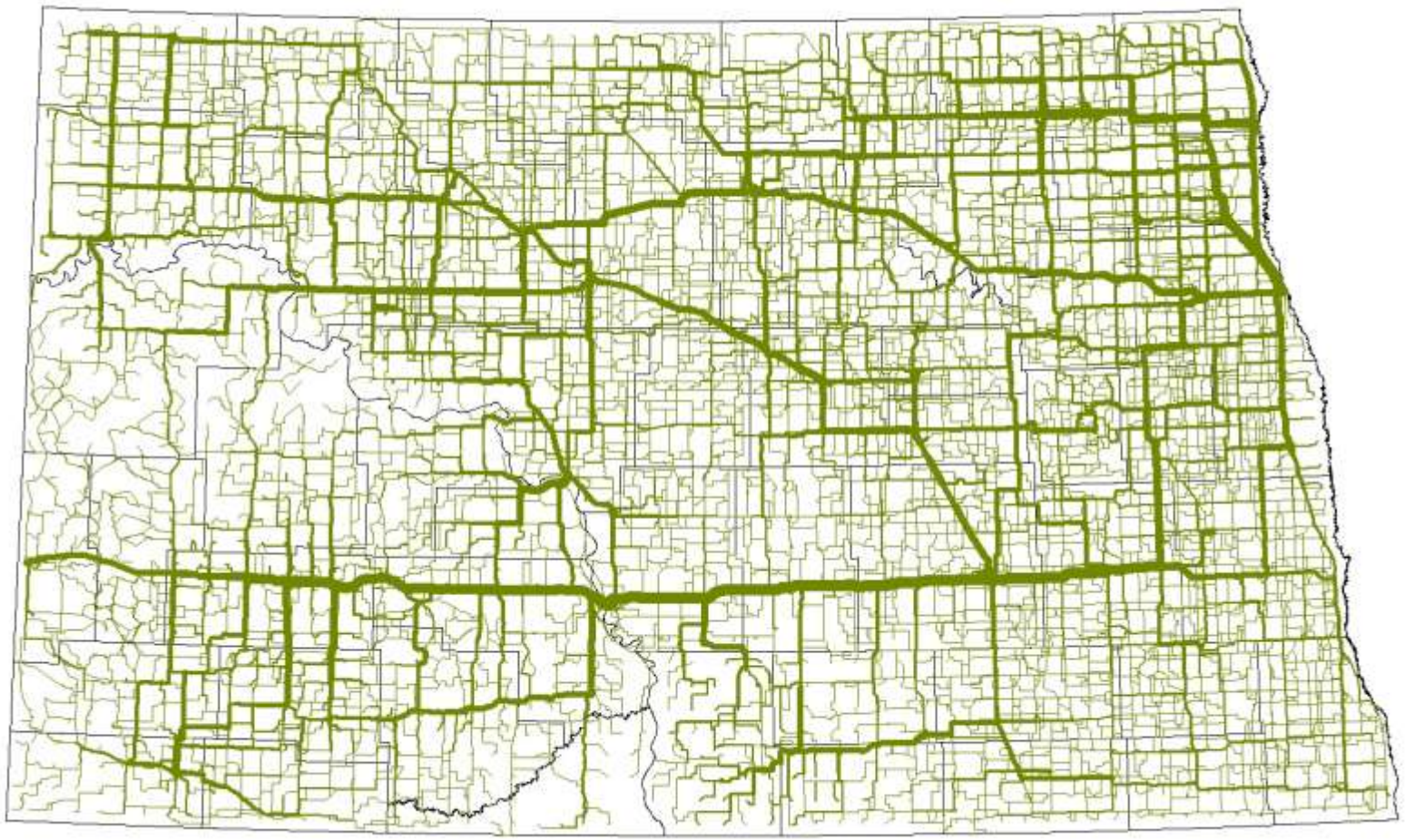
Crop Production and Location



Grain Distribution Network



Crop Movement Projections - Wheat



Ohio River Basin Grain GIS Model

Developed for the U.S. Army Corps of Engineers

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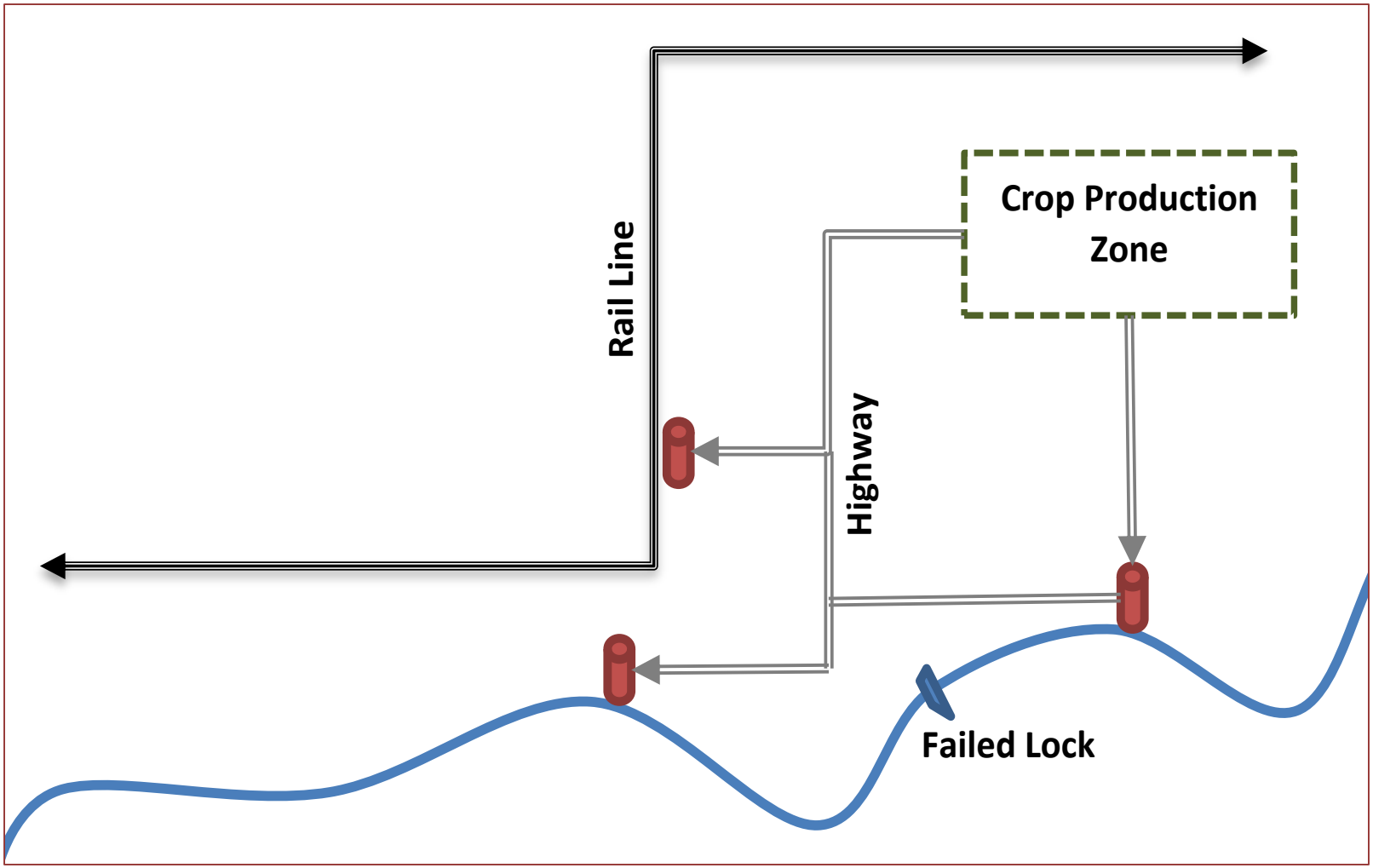
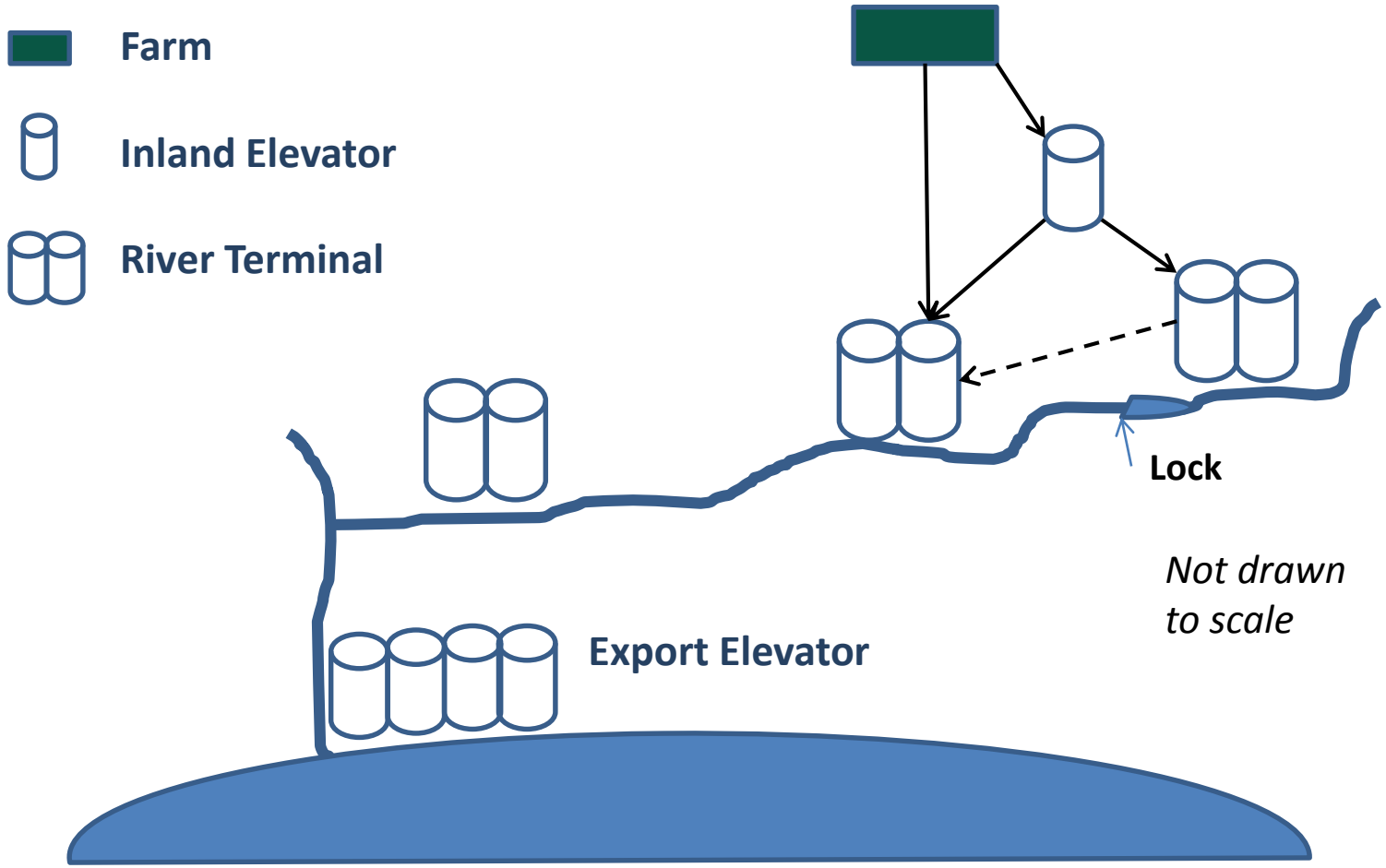
River Basin Network: Abstract Representation



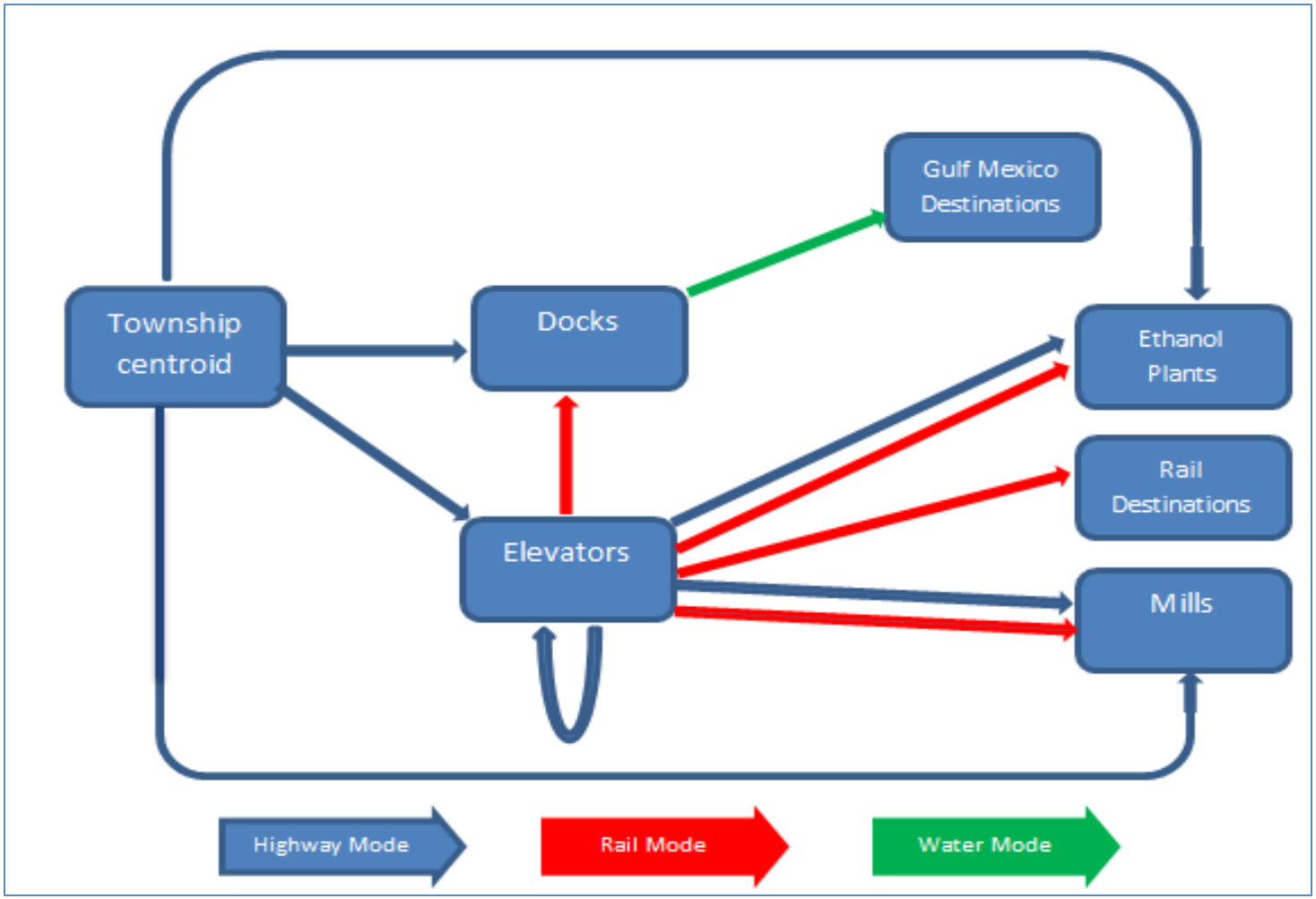
Complex Analysis Process

- If a lock or dam fails, the distribution path of a commodity may change at origin
- Instead of continuing to ship to a dock located upstream of a failed lock, an inland elevator may ship by rail or truck to a downstream dock
- As time progresses, decisions are made farther up the supply chain
  - If prices offered by elevators change as a result of changes in transportation costs, farm producer may sell to a different elevator or utilize an alternative marketing channel

Grain Marketing Channels



Network Flow Patterns

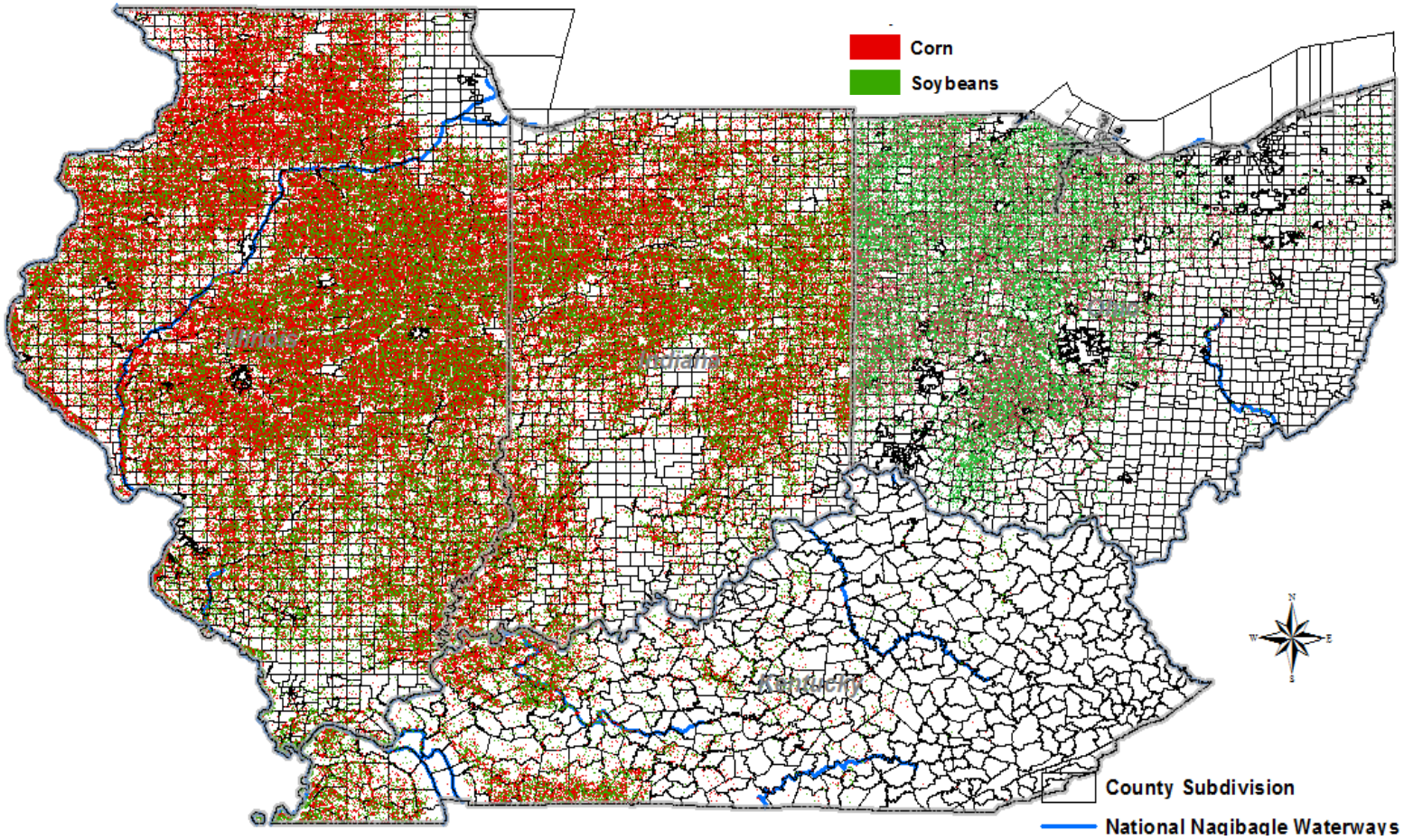


Agricultural Land Use Model: Ohio River Basin Study

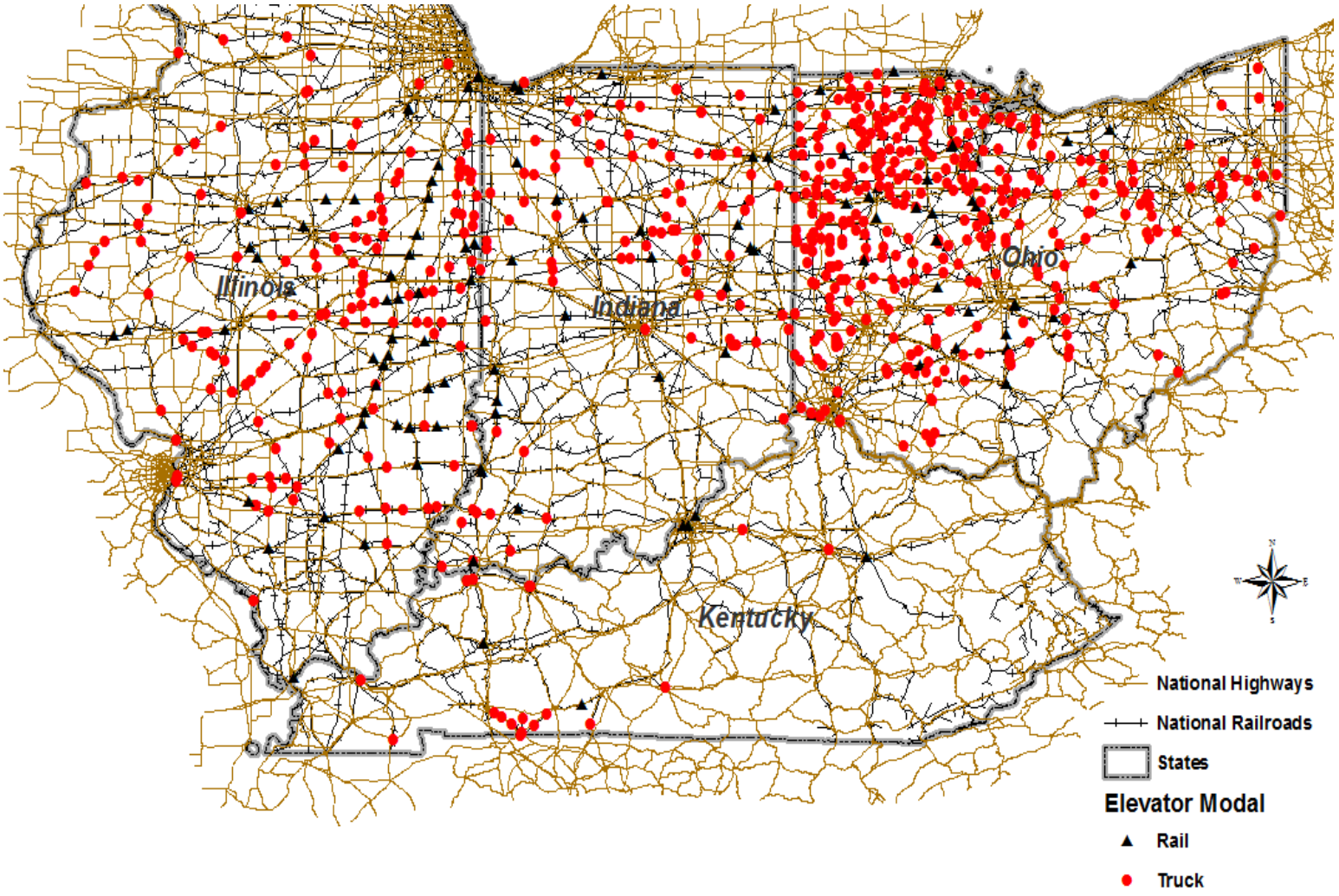
8,032 County Subdivisions

State	Subdivisions
Illinois	1,710
Indiana	1,011
Kentucky	493
Ohio	4,818

Crop Production: Ohio River Basin



Elevator Network: Ohio River Basin



Future Work and Directions

- Railroads: start with FRA/ORNL network
  - Expand segment attributes
  - Terminals
  - Highway grade crossings
  - Routing/risk assessment
  - Emergency response
- Highways
  - Bridges and structures
  - Impedance functions/friction factors
    - Inherently non-linear
  - Congestion effects